

THE MACHINES OF PERCEPTION

A Thesis
Presented to
The Academic Faculty

by

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In Partial Fulfillment
of the Requirements for the Degree
Masters of Architecture in the
School of Architecture

Georgia Institute of Technology
May 2008

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Date Approved: 3/31/08

ACKNOWLEDGEMENTS

I wish to thank Professors Lars Spuybroek, Sonit Bafna, and Stuart Romm for their insight and patience.

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SUMMARY

The following work is an attempt to feed a dynamic concept of the body into contemporary morphogenetic design procedures in order to confront critiques that topological design processes produce architectural form that is *too abstract*. This begins with an understanding of the body schema; the open and continuously variable relationships between the various modes of sensation and perception that can only be described in topological terms. Similar to how active matter is instrumentalized in *avant-garde* practice and cutting edge research towards self-organization and morphogenesis, an active body schema has the potential to be instrumentalized towards design that aims to exploit the potential performance and openness of the body when confronted with architecture, moving away from mechanistic, representational notions of function. The work follows a procedure wherein conceptual research engages physical phenomena that are abstracted into diagrams then organized into material systems or abstract machines. These machines are intended to be mobilized and consolidated to engage specific issues of program and type and further refined to be deployed upon a specific site. This morphological process of machining architecture aims to move toward a seamless exchange between research and design that effectively instrumentalizes the dynamic body schema into a design process engaging architecture of performance. Perhaps, in terms of the body, morphogenetic design produces architecture that is *not abstract enough*.

CHAPTER 1:

Methodology

Prior to any specific research agendas, the proceeding work will be motivated by a specific methodological tact. This is a reaction to traditional pedagogy which reinforces, to some degree, a break between theory and design. Most design studios begin with some sort of study, whether it is architectural precedent, theory analysis, or some more abstract engagement. There seems to always be some stark moment where the theorizing and study is stopped and design begins. It may be that some trace of the initial research remains apparent in the design, but this appearance is rarely anything more than some shallow representation or visual poetic and rarely has any affect the performance of a design in any rigorous way. In essence, it is at this break that the architect is left in a state of flux and is forced to either leap into design, severing concrete ties with theory, or to retreat back to the world of words and poetics. At this all important moment in any design process, information derived from initial undertakings is all but lost, leaving a project drained of performative rigor and abundant with desperate poetics all for the sake of validating its conceptual beginnings. Even in professional practice it is all too common for architects to write or research only to prove their work to be valid, rather than pursuing a project that truly is inseparable from its processes; a design that speaks- and performs- for itself. Therefore, it is the initial goal of this research to bridge this gap through an emphasis on *instrumentalizing* of the research.

Effectively unifying the design process calls for a seamless process where research and design- theory and practice- are continuously feeding back into each other and ultimately blurred through the final design. Architect Lars Spuybroek referred to this as a *machining* process that begins first with a movement of virtualization. This involves the gathering and selection of information (research) which is analyzed and abstracted

into a system, then organized into a specific diagram or abstract machine towards a certain quality, order, and organization. Next, a movement of actualization, where the machines become formative, whether it be the organization of program, structure, aesthetics, or otherwise (Spuybroek 6-9). From a system, to flexibility and openness, to rigid morphology, this process literally instrumentalizes research and information towards specific architectural intentions. The gap between theory and practice is foregone in favor of a process where research and design are inseparably linked in a continuum of feedback. These abstract machines bridge the gap and result in a design process where theory and research become performative elements of design rather than mere inspiration or representations.

For this thesis, work will proceed in a similar fashion. A theoretical framework will be established that proposes a challenge to contemporary design processes through the engagement of a dynamic body schema. This initial text research, in combination with certain examples of physical phenomena will be abstracted and diagrammed into specific systems. These systems will then be organized into abstract machines that at once instrumentalize the research and are tailored to specific architectural issues and performative goals. The resulting morphology will then be fed forward into further architectural specificities and tailored towards a final design, and ultimately a building project. Under these circumstances, this text will serve less as a defense of a design process as is typically expected, and more as a description of a procedure that explores the performative potential of architecture through a specific methodology, beginning with the outline of theoretical web that establishes its intentions.

Body-Schema

Contemporary experimental research and avant-garde design have embraced the dynamic properties of material systems as design techniques through the use of cutting-

edge modeling and fabrication technology. The morphogenetic and self-organizational qualities that emerge from these ventures are essentially beginning and ending with matter. But what of the body in this space? Historically, the various modes of architectural design theory have at some point in their respective evolutions considered the relationship of architecture to the body. Is there some opportunity for the body to assert itself in these dynamic processes? Do these emerging methodologies present the potential for new relationships between the body and built form? This research intends to begin with an understanding of the body and its perceptual systems as dynamic and morphogenetic processes that can be instrumentalized and fed forward into architecture; folded into these new methodologies in a way that addresses the potential of the body beyond functional issues of scale and use towards unleashing the potential of performance in the relationship between the body and the built environment.

Morphogenesis was originally a concept of developmental biology. It describes the evolutionary processes of growth and form generation in organisms. It has recently been adopted by architects and theoreticians to describe design processes that embrace a bottom up approach of organization and form generation. In some sequence, the dynamics of material systems are instrumentalized and fed into digital design models through parametric software. These digital techniques produce structural forms which evolve through a process that tailors them towards specific architectural performances. What typically results are what is commonly (and unfortunately) compared to sculptural or ‘organic’ forms, but what is overlooked is the rigor and specificity of these forms that are inseparable from these morphogenetic processes managed by digital techniques. Regardless of these empty comparisons, the general critique can be boiled down to a view of these forms as too abstract to relate to the human body and its functional needs; there is no relationship to the body. Also, these dynamic animated processes betray the static forms of Architecture. What is the relationship between non-Euclidean forms and reality?

This critique ultimately depends on how we understand the body. What if the space of the body is really abstract? What if the body is inseparable from dimensions of lived abstractness and cannot be conceptualized in other than topological terms? This is where topological architecture is carnally challenged and proves inadequately abstract. It does well with the involuntary in the form of chance variations programmed into the topological form generating software. It does much less well with the elicited; its opportunity to expand the potential performance as it engages with the dynamic body. Putting the two together is necessary for grasping the minded body's mode of reality; combining the involuntary logic of material systems with a logic of the effects of form on a dynamic body. No single logic, geometric or otherwise, is flexible enough to encompass the concrete abstractness of experience. Just as the body lives between dimensions, designing for it requires operating between logics. To be sufficiently abstract, topological architecture needs to welcome the *translogical*. A *translogic* is different from a *meta-logic*. It does not describe multiple logics and the operative levels they hold together, but it enters the relations and tweaks as many as it can to get a sense of what may come. It is effective rather than meta-logical, it is *supermodulatory* (Massumi 177-78). It is not that architecture does not already go about its business like this in certain regulatory manner, as when it proudly deconstructs positively absent structures or privileges determinations of history over potential becomings, or cruelly cites when it could be effectively tweaking or boringly domiciles the world in its own supposed prereflection. If architecture pursues extending its diagrams into *biograms*, the translogical organizations at once a material system and a dynamic conception of the body, it will become more what it has always been; a materialist art of qualitative body modulation, a translogical engineering of matter gone mindful. Its buildings will also be more what they are; more modulatory, more flexibly membranous, more intensely lived between more relational dimensions brought concretely into abstract surface proximity (Massumi 191).

Body-schema was first understood to mean a compendium of our bodily experience capable of giving a commentary and meaning to the internal impressions and the impression of possessing a body at any moment. Maurice Merleau-Ponty describes the body-schema in detail in part I of *The Phenomenology of perception*. It was supposed to register the positional changes of the parts the body for each movement of one of them, the position of each local stimulus in the body as a whole, an account of the movements performed at every instant during a complex gesture, in short a continual translation into visual language of the kinesthetic and reticular impressions of the moment. When the term body-schema was first used it was thought that nothing more was being introduced than a convenient name for a great many associations of images and it was intended merely to convey the fact that these associations were firmly established and constantly ready to come into play; the virtual-body. Body-schema was supposed to gradually show itself through childhood in proportion as the tactile, kinesthetic, and articular contents were associated among themselves or with visual contents. Its physiological representation could then be no more than a focus of images in the classical sense. Yet in the question made of it by psychologists it is clear that the body schema does not fit into this associationist definition. For example, in order that the body schema may elucidate allochiria, it is not enough that each sensation of the left hand should take its place among generic images of all parts of the body acting in association to form around the left hand, as it were, a superimposed sketch of the body, these associations must be constantly subject to a unique law, that spatiality of the body must work downwards from the whole to the parts, the left hand and its position must be implied in a comprehensive bodily purpose and must organize in that purpose so that it may be at one stroke not only superimposed on or cleave to the right hand, but actually become the right hand. Only if the body schema, instead of being residue of habitual senesthesis, becomes the law of its constitution. The inter-sensory or the sensory-motor unity of the body is, so to speak, *de jure*, that it is not confined to contents actually and fortuitously associated in the course of

our experience, that it is in some way anterior to them and makes their associations possible. It is during experience, but a total awareness of my posture in the inter-sensory world, a form, in the sense used by gestalt psychologists. It is inadequate to say that the body is a form, that is to say a phenomenon in which the totality takes precedence over the parts. How much is such a phenomenon possible, because a form compared to the mosaic of a psycho-chemical body or to that of synesthesia is a new type of existence. The fact that the paralyzed limb of the amosognosic no longer counts in the subject's body-schema, is accounted for by the body-schema being neither the mere copy, nor even the global awareness of the existing parts of the body. The body-schema is dynamic. And indeed its spatiality is not like that of external objects like that of spatial sensations, or spatiality of position, but a spatiality of situation. It is not that I am unaware of the whereabouts of my shoulders or back, but these are simply swallowed up in the position of my hands and my whole posture can be read in the pressure that they exert on the table. If my body can be a form and if there can be in front of it important figures against indifferent backgrounds, this occurs in virtue of its being polarized by its tasks, of its existence towards them, of its collecting together of itself in its pursuit of its aims; the body schema is finally a way of stating that my body is in the world (Merleau-Ponty 77-84). I am no longer concerned with my body or with time or the world, as I experience them in ante-predicative knowledge, in the inner communion that I have with them. I now refer to my body as only an idea to the universe, as an idea and to space, as an idea of time. To the extent that I have sense organs, a body, and psychic functions comparable with other men's, each of the moments of my experience ceases to be an integrated and strictly unique totality. I become the meeting point of a host of causalities insofar as I inhabit a physical world. My foot hurts means not: I think that my foot is the cause of this pain, but that pain comes from my foot, or again my foot has a pain, this is shown clearly by the primitive voluminousness of pain formerly spoken of by

psychologists. But the notion of the body-schema is ambiguous as are all notions of their appearance at turning points in scientific advance (Merleau-Ponty 103-05).

What if the space of the body is really abstract? What if the body is inseparable from dimensions of lived abstractness that cannot be conceptualized in other than topological terms? In these terms the body exists, and must be understood as a schema; as the organization and relation between its various modes of perception, inseparable from lived experience. To feed this concept into the design process, research must first progress toward an analysis of the body-schema. What exactly are these modes of perception, how do they operate, and what are the relationships that result in, and are inseparable from what we know as lived experience? What is the relationship between a perceiving body and that which it perceives? The various modes of perception must be understood as components in a unity that serves to differentiate various sources of stimulus information. Perception can only be understood as an act that is learned, as habit, to form our typical active relationship with the environment. Habits and tendencies evolve throughout our development that unconsciously organize and differentiate stimulus information and over time the act of perception becomes imperceivable. This research will begin with visual perception, and progress through its relationships with other *extero* and *proprio* modes of perception towards an understanding of the construction and continuous variation of the body-schema. What emerges is something that can only be described topologically; the body as the law of its changes, the matrix of habitual action, a higher state of form that is understood through rates and speeds rather than fixed distance and ideal statics. Also, perception is always perception of something. The body relates to space and perceives space through motion. Perception is derived from motion, and the schema is constructed and varied through motion; the topological body as the law of relationships between perception and movement.

CHAPTER 2:

Proprioception

The analysis of the constructive process of the body schema will begin with its most apparent component; visual perception. Research will specifically engage the work of J.J. Gibson's text, *An Ecological Approach to Visual Perception*, which provides a concept of perception as perception of a meaningful environment through a process of the reception of stimulus information and differentiation of invariants and change within this information. This specific description provides the basis for a rich and dynamic understanding of the relationship between the body and landscape. Most importantly is the revelation that visual perception alone does not constitute anything. Perception of a meaningful environment involves the complementarity of the extero-senses with less apparent, but perhaps more influential senses; those of proprioception (Gibson 182). These senses continuously feed into and out of each other as a body moves through a landscape in an act of construction where perception ultimately emerges from movement. The concept of proprioception similarly leads to issues of orientation and memory and begins to shed light on the mechanistic understandings of the body that are embraced across various design fields.

First, it is obvious that there are perceptual systems other than the visual system that are active and that the body is a source of stimulus information for these other senses as well as for vision. Proprioception is typically either taken to be one of these senses by sensory psychologists or taken to be several related senses. Proprioception can be understood as ego reception, as sensitivity to the self, not as one special kind of sensation or several of them. It is a self-referential sense, in that what it most directly registers are displacements of the parts of the body relative to each other. Vision is an exo-referential sense, registering distances from the eye. All of the perceptual systems are

propriosensitive as well as exterosensitive, for they all provide information in their various ways about the observer's activities. The observer's movements usually produce sights and sounds and impressions on the skin along with stimulation of the muscles, the joints, and the inner ear. Accordingly, information that is specific to the self is picked up as such no matter what sensory nerve is delivering impulses to the brain. An individual not only sees himself, he hears his footsteps and his voice, he touches the floor and his tools, and when he touches his own skin he feels both his hand and his skin at the same time. He feels his head turning his muscle flexing and his joints bending. He has his own aches, the pressures of his own clothing, the look of his own eyeglasses-in fact; he lives within his own skin. The optical information to specify the self, including the head body, arms, and hands accompanies the optical information to specify the environment. The two sources of information coexist; one could not exist without the other. When a man sees the world, he sees his nose at the same time, or rather, the world and his nose are both specified and his awareness can shift. Which of the two he notices depends on his attitude; what is important is that information is available for both (Gibson 183).

In these terms, the supposedly separate realms of the subjective and the objective are actually only poles of attention. The dualism of observer and environment is unnecessary. The information for the perception of 'here' is of the same kind as the information for the perception of 'there' and a continuous layout of surfaces extends from one to the other. Drivers of cars see where they are going, if they pay attention. A bee that lands on a flower must see where it is going. All of them at the same time see the layout of the environment through which they are going. This is a fact with extremely radical implications for psychology, for it is difficult to understand how a train of signals coming over the optic nerve could explain it. How could signals have two meanings at once, a subjective meaning and an objective one? How could signals yield an experience of self movement and an experience of the external world at the same time? How could visual motion sensations get converted into a stationary environment and a moving self?

The doctrine of the special senses and the theory of sensory channels come into question. A perceptual system must be at work that extracts invariants. Exteroception and proprioception must be complimentary (Gibson 183-84).

Perceiving is an act not a response. An act of attention not a triggered reflex, an achievement. The perception of 'surfaceness' depends on the proximity to one another of discontinuities in the optic array. Note that the perception of the ground and the co-perception of the self are inseparable in this situation. One's bodies' relation to the ground is what gets attention. Perception and proprioception are complementary. I do not translate the data of touch into the language of seeing or vice versa- I do not bring together one by one the parts of my body, this translation and this unification are performed once and for all within me they are my body itself. The body is to use Leibentz term, the effective law of its changes (Gibson 182).

These senses, unconscious and automatic, had to be discovered. Historically, their discovery came late: what the Victorians vaguely called 'muscle sense' –the awareness of the relative position of the trunk and limbs, derived from receptors in the joints and tendons- was only really defined (and named proprioception) in the late 1890's. The complex mechanisms and controls by which our bodies are properly aligned and balanced in space-these have been defined in our own century, and still hold many mysteries. If proprioception is completely knocked out, the body becomes, so to speak, blind and deaf to itself-and ceases to own itself, to feel itself as itself. Examples of similar disorders reveal the essential nature of the relationship between exteroception and proprioception. Instances of 'psychic blindness' prove to completely throw off 'normal' experience in terms of vision and movement (Sacks 71). An example of morbid motility by Merleau-Ponty clearly shows the fundamental relations between the body and space. A patient whom traditional psychiatry would class among cases of psychic blindness is unable to perform abstract movements with his eyes shut, movements which are not relevant to any actual sensation such as moving arms and legs to order or bending and

straightening a finger. Nor can he describe the position of his body or even his head or the passive movements of his limbs. Also, when his head, arms, or leg is touched he cannot clearly identify the point on his body. He manages the abstract movements only if through preparatory movements involving the whole body. The localization of stimuli and recognition of objects by touch also become possible with the aid of preparatory movements. Even when his eyes are closed if the patient performs with extraordinary speed and precision the movements needed in living life provided that he is in the habit of performing them; he takes his handkerchief from his pocket and blows his nose, takes a match out of a box and lights a lamp. He is employed in the manufacture of wallets and his production rate is equal to three quarters of that of a normal workman. He can even without preparatory movements perform these concrete movements in order. In the same patient and also cerebellar cases one notices a disassociation of the act of pointing from reactions of taking or grasping, the same subject who is unable to point to order a part of his body, quickly moves his hand to the point where a mosquito is stinging him. If I know where my nose is when it is a question of holding, how can I not know where my nose is when it is a matter of pointing to it. It is probably because knowledge of where something is can be understood in a number of ways. The patient is conscious of his bodily space as the matrix of his habitual action, but not as an objective setting, his body is at his disposal as a means of ingress into a familiar surrounding, but not as the means of expression of a gratuitous and free spatial thought. Merleau-Ponty elaborates:

“ I experience the movements as being a result of the situation, of the sequence of events themselves, myself, and my movements are, so to speak, merely a link in the whole process and I am scarcely aware of any voluntary initiative. In the same way, in order to make a movement to order he places himself in flows as in real life. There is my arm seen as sustaining familiar acts, my body as giving rise to determinate action having a field s or scope known to

me in advance there are my surroundings as a collection of possible points upon which this bodily action may operate. The world as a pure spectacle into which I am not absorbed, but which I contemplate and point out. There is no question of locating it in relation to axes of coordinates in objective space, but of reaching with his phenomenal hand a certain painful spot on his phenomenal body. The perception of the body and of objects in contact with the body is vague when there is no movement. His body when touched is not presented to him as a geometrical outline in which each stimulus occupies an explicit position. Schneider's disease lies precisely in his need, in order to find out where he is being touched, to convert the bodily area touched into a shape." (Merleau-Ponty 173-75).

The motor disturbances of cerebellar cases and those of psychological blindness can be coordinated only if we identify the basis of movement and vision not as a collection of sensible qualities but as a certain way of giving form or structure to our environment. Although Schneider's trouble affects mobility and thought as well as perception the fact remains that what it damages particularly in the domain of thought is his power of apprehending simultaneous wholes. Mobility as basic intentionality. Consciousness is in the first place not a matter of I think that, but of I can. Sight and movement are specific ways of entering into relationship with objects and if through all these experiences some unique function finds its expression it is the momentum of existence which does not cancel out the radical diversity of contents because it links them to each other but by placing them all under the control of an 'I think', but by guiding them towards the inter-sensory unity of a world." (Merleau-Ponty 171-78).

But it must be said that a disease is never a mere loss or excess-that there is always a rejection, on the part of the affected organism or individual, to restore, to replace, to compensate for and to preserve its identity, however strange the means may

be. Oliver Sacks describes a patient referred to as Christina, who suffers from sensory neuritis (psychic blindness) in 'The Man who Mistook his Wife for a Hat'. This similarly affects the continuous but unconscious sensory flow from the movable parts of our body (muscles, tendons, joints), by which their position and tone and motion are continually monitored and adjusted- proprioception. The sense that our bodies are beyond question, or perhaps beneath question-they are simply, unquestionably, there. "I've already noticed," she added, musingly, "that I may lose my arms. I think that they're in one place and I find they're another." She could at first do nothing without using her eyes, and collapsed in a helpless heap the moment she closed them. Increasingly, week by week, the normal unconscious feedback of proprioception was being replaced by an equally unconscious feedback by vision, by visual automatism and reflexes increasingly integrated and fluent. Was it possible too that something more fundamental was happening? That the brain's visual model of the body, the body-image –normally rather feeble (it is, of course, absent in the blind), and normally subsidiary to the proprioceptive body-model-was it possible that this, now the proprioceptive body model was lost, was gaining, by way of compensation or substitution, an enhanced, exceptional, extraordinary force? "I feel my body is blind and deaf to itself....it has no sense of itself" – these are her own words. She has no words, no direct words, to describe this void, this sensory darkness (or silence) akin to blindness or deafness (Sacks 43-55).

On the other hand is clinical synesthesia. Massumi Describes this as a condition where a hinge dimension of experience, usually lost to active awareness in the sea of change to adulthood, retains the ability to manifest itself perceptually. In synesthesia, other sense dimensions become visible, as when sounds are seen as colors, sensation and perception are overabundant. This is not vision as it is thought cognitively. It is more like other sense operations at the hinge with vision, registered from its point of view. Synesthetic forms are described as dynamic. They are not mirrored in thought; they are literal perceptions. They are not reflected upon, they are experienced as events.

Synesthetic forms are forms are used by being summoned into present perception then recombined with an experience of movement. Since they work by calling forth a real movement-experience, they retain a privileged connection to proprioception. Although synesthetic forms are often called ‘maps’, they are less cartographic in the traditional sense than diagrammatic in the sense now entering architectural discourse. They are lived diagrams based on already lived experience, revived to orient further experience. Lived and relived: biograms might be a better word for them than diagrams. It is accompanied by a feeling of portentous dejavu: an already-past pregnant with futurity, in present perception. This makes experiencing biograms like ‘seeing time in space’. Biograms are not plainly visible forms. They are more than visual. They are event-perceptions combining senses, tenses, and dimensions on a single surface. They are described as geometrically strange: a foreground-surround, like a trick center twisting into all-encompassing periphery. Biograms are often described as occupying the otherwise dimensionless plane between the eyes and objects in the world. “Seeing time in space...a good way of describing an event.” It is as if all the dimensions of experience are compressed into vision. There is no fundamental difference between perception, hallucination and cognition. It is the hinge plane not only between senses, tenses, and dimensions of space and time, but between matter and mindedness: the involuntary and the elicited (Massumi 186-90).

Body Abstraction

It is the goal of this research to begin to develop a design process that accounts for the kinesthetic qualities of proprioception and the synesthetic potential of space. In order to properly instrumentalize the body, an abstraction must occur that approaches the synesthetic level of the biogram that Massumi has described. The body must be digitized in a way that retains proprioceptive and visual interferences. Abstracting the body for

certain scientific or design related purposes is a problem that has been confronted since as early as the 19th century, beginning with anthropometry, the measurement of humans.

Anthropometry

Anthropometry refers to the measurement of living human individuals for the purposes of understanding human physical variation. Alphonse Bertillon gave this name in 1883 to a system of identification depending on the unchanging character of certain measurements of parts of the human frame. He found by patient inquiry that several physical features and the dimensions of certain bones or bony structures in the body remain practically constant during adult life (fig.2.1).



Fig. 2.1 Bertillon Facial Measurement

He concluded from this that when these measurements were made and recorded systematically every single individual would be found to be perfectly distinguishable from others. The system was soon adapted to police methods, as the immense value of

being able to fix a person's identity was fully realized, both in preventing false impersonation and in bringing home to any one charged with an offense his responsibility for previous wrongdoing (Pheasant 24). Today, anthropometry plays a role in industrial design, clothing design, and architecture, where statistical data about the distribution of body dimensions in the population are used to optimize products through ergonomics or the broad field of human factors.

Ergonomics

Ergonomics is the application of scientific information concerning objects, systems and environments for human use. It is a specific field of human factors, the applied science of equipment design intended to maximize productivity by reducing operator fatigue and discomfort (fig. 2.2).

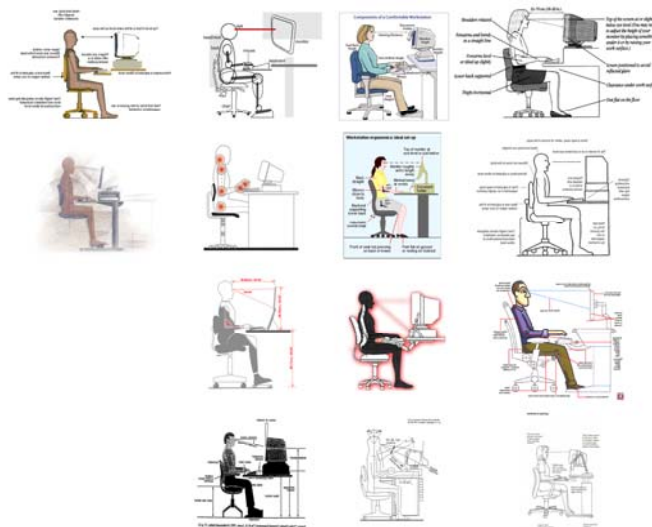


Fig 2.2 Ergonomics in the Office

In the 19th century, Frederick Winslow Taylor pioneered the "Scientific Management" method, which proposed a way to find the optimum method for carrying out a given task. Taylor found that he could, for example, triple the amount of coal that workers were shoveling by incrementally reducing the size and weight of coal shovels

until the fastest shoveling rate was reached. Frank and Lillian Gilbreth expanded Taylor's methods in the early 1900s to develop "Time and Motion Studies". They aimed to improve efficiency by eliminating unnecessary steps and actions. World War II marked the development of new and complex machines and weaponry, and these made new demands on operators' cognition. The decision-making, attention, situational awareness and hand-eye coordination of the machine's operator became key in the success or failure of a task (Pheasant 39).

It was observed that fully functional aircraft, flown by the best-trained pilots, still crashed. In 1943, Alphonse Chapanis, a lieutenant in the U.S. Army, showed that this so-called "pilot error" could be greatly reduced when more logical and differentiable controls replaced confusing designs in airplane cockpits (Pheasant 21-44). In essence, the science of ergonomics uses anthropometry and certain cognitive tendencies as standards or normals around which a 'good design' may develop. Physical ergonomics in particular rely on standardized measurements and ranges of motion of the body that are to serve as the dimensional basis for design. Further, ergonomics relies on specific optimized postures that are encouraged during specific actions in order to avoid injuries from repetitive stress and increase awareness of the task at hand. This mechanistic understanding of a static, generalized body in ideal postures and reductive movements seeks to turn the body into an ideal machine through the skilful design of products. From classical anthropometry to contemporary use of ergonomics we see a mechanistic view of the body that completely denies a dynamic body-schema and the openness of proprioception. Fixed idealized postures and generalized metric descriptions deny the inherent motility of the body. Even while seemingly at rest, the body is constantly undergoing imperceptible minute movements and adjustments. Also, while in motion the dynamic body schema is continuously varying and adjusting its postures and headings through the coexistence of extero and proprioception stimulations that cannot be described by mechanistic postures. To effectively abstract the body with the goal of

retaining its dynamic, topological qualities is to move beyond these metric descriptions and ideals of a static body. Proprioception cannot be defined by fixed measurements or static postures since it is constantly registering change. An abstraction of the dynamic body can only be accomplished through a description of the body constantly becoming different over time, and how this differentiation can become productive through interference.

Etienne-Jules Marey

Historically, attempts have been made to achieve a more dynamic abstraction of the body, specifically the body in motion. Capturing the body in motion begins to break away from the static, mechanistic ideals of an ergonomic body and begin to shed light on a dynamic differentiation of the body, proprioception, through the variable of time. Early experiments include those by Étienne-Jules Marey. Marey began his explorations by studying how blood moves in the body, and then shifted to analyzing heart beats, respiration, muscles, and movement of the body. Marey became fascinated by movements of air and started to study bigger flying animals, like birds and as a result adopted and further developed *animated photography* into a separate field of *chronophotography* in the 1880s. His revolutionary idea was to record several phases of movement on one photographic surface. Marey developed the chronophotographic gun in 1882 to achieve this. This instrument was capable of taking 12 consecutive frames a second, with all the frames recorded on the same picture. The pictures were used to study a variety of animals in motion and to further understand his chronophotographic images; he compared them with images of the anatomy, skeleton, joints, and muscles of the same species (fig. 2.3).

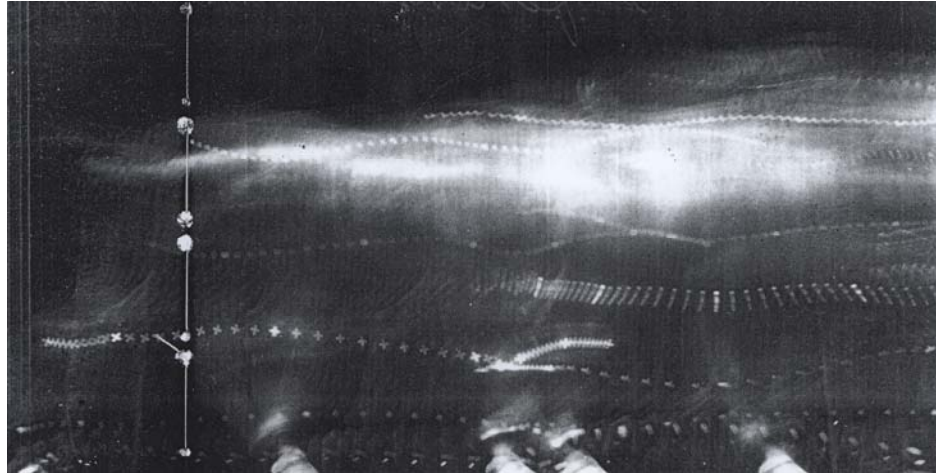


Fig. 2.3 Marey : Horse in Motion

Marey produced a series of drawings showing a horse trotting and galloping, first in the flesh and then as a skeleton. Marey also studied human locomotion as published in the book *Le Mouvement* in 1894 (fig. 2.4).



Fig. 2.4 Marey : Man Long Jump

It was the goal of these experiments to study the movements of animals on an abstract level through new photographic techniques (Dagognet 41-55). Exposures were superimposed and luminous markers were attached to the animals at certain joints to further abstract movement. What emerged was a ghosted blur of the body proper with undulating streaks of the markers, each with a specific rhythm as the body bounded through space and time. Rather than describing a body as it ideally stays the same, as in

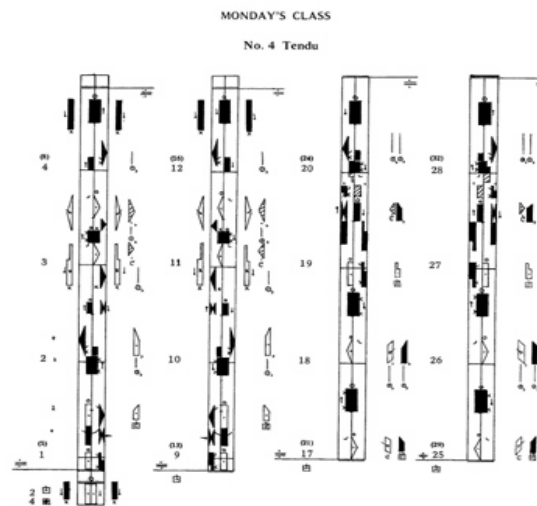
ergonomics and anthropometry, Marey revealed an image of a dynamic body, one that is constantly changing through several scales of movement. Marey began to describe a body as the relationship between its changes over time through the relationships between anatomy, environment, and movement. His images were at once a symptom of the body and its parameters, and the qualities of the environment through which it was moving. A horse running along a wooden floor produces quite different rhythms than one running along a rubber floor, just as the rhythms and differences of a man's body walking along a street differ from those of a man walking up stairs.

Labanotation

Similarly, the work of Rudolf Laban seeks to break from mechanistic descriptions and move towards a dynamic body of continuous variation. Labanotation is a system of movement notation that is used for dance notation. Labanotation uses abstract symbols to define direction of the movement, part of the body doing the movement, level of the movement, and length of time it takes to do the movement. The shapes of the symbols indicate nine different directions in space and the shading of the symbol specifies the level of the movement. Labanotation is a record of movement that could potentially describe all movements of the human body. The symbols are placed on a vertical staff, the horizontal dimension of the staff represents the symmetry of the body, the vertical dimension time, and the location of the symbol on the staff defines the body part it represents. The centre line of the staff represents the centre line of the body, symbols on the right represent the right side of the body, and symbols on the left, the left side. The staff is read from bottom to top and the length of a symbol defines the duration of the movement. Drawing on western music notation, Labanotation uses bar lines to mark time measures and double bar lines at the start and end of the movement score. Spatial

distance, spatial relationships, transference of weight, centre of weight, jumps, turns, body parts, paths, and floor plans can all be notated by specific symbols.

Laban's theories of effort (Laban Movement Analysis) can also be represented in Labanotation. The four effort categories are space: direct / indirect, weight: strong / light, time: sudden / sustained, and flow: bound / free. The basis is natural human motion, and every change from this natural human motion (e.g. turned-out legs) has to be specifically written down in the notation (Davies 22-50). Similar to how a sheet of music serves to modulate various qualities of sound, Labanotation deals in the realm of intensities, rhythms, and rates, as opposed to ergonomics which can only accommodate fixed metrics and postures. At best, this notation serves as open instruction and may not be performed the same way twice. Since there are no specific measurements or measured postures expressed in the notation, the instructions are interpreted and expressed through the abstract space of the body (fig. 2.5).



Labanotation from Bournonville's Monday Class, Tendu
Photo courtesy Lois Rathvon

Fig. 2.5 Labanotation

Labanotations represent the relationships between the body parts based on a certain rhythm or intensity over time; it operates on a proprioceptive level.

Body Diagramming

What if architecture could find ways of imbedding in the materiality of building's open invitations for the proliferation of performance? Might this be a way of continuing its topological process in its product? According to Massumi, to do this would somehow require integrating logics of perception and experience into modeling. Processes like habit and memory would have to be taken into account as would the reality of intensive movement (proprioception). Techniques would have to be found for overfilling experience. The methods would have to operate in a rigorously anexact way, respecting the positivism of the virtual's vagueness and the openness of its individual endings. Never prefiguring. Architecture could even surpass synesthetes by finding ways of building in non-visual hyper-surfaces. There is nothing wrong with color, light, and darkness. Rainbows of experience are good, but imagine the startling effects that might be achieved by using proprioception as the general plane of cross referencing. Technologies that can be twisted away from addressing preexisting forms and functions toward operating directly as technologies of emergent experience could be favored. Imagine if these were to become infrastructural to architectural engineering. Approached not only as design tools but as architectural elements as basic as walls and windows. Could architecture build on the ability of digital technologies to connect and interfuse different spheres of activity on the same operational plane, to new affect? This is a direction in which the work of Lars Spuybroek, among others is moving. If architecture were to make its mission to build in biogramatic triggers or performance elicitation devices rather than contenting itself with all too cognitive citations it would have outgrown its moniker as a spatial art. It would have become not just metaphorically historical, but a literal technology of time. It would be as directly an art of time as of space, concerned with eliciting their continuous looping into and out of each other in mutual reaccess and renewal (Massumi 191-92).

It is therefore the goal of these diagrams to serve as an abstraction of the dynamics of proprioceptive senses in terms of intensities of differentiation. Where typical descriptions of the body utilized in ergonomics rely on ideal metrics and static postures that ultimately limit the potential of the body towards function, these abstractions aim to describe how the body is becoming different over time through rhythms and intensities, to accommodate the dynamic body in continuous variation towards the potential of performance. First, there must be an understanding of human action in these terms. Various actions can be classified and plotted in relation to two variables; differentiation, or the degree to which the body is becoming different from its previous state, and intensity, or the rapidity or slowness to which this change is occurring. Intensities range from casual (not intense) to violent (very intense) while differentiation ranges similarly from high difference to low. In terms of the body in action, activities such as sleeping and watching are both of low intensity and differentiation, while running or climbing can be understood as violent change of high differentiation. On the other hand typing or writing can be understood as high intensity, low differentiation while performing yoga or thai chi is of low intensity and high differentiation. Any hypothetical action can be plotted on such a graph which ultimately serves to hint at a specific rhythm to an action. In terms of the body, this differentiation is the result of the change of the angle at a joint over a certain increment of time. For example, while walking, the angle formed by the two halves of the leg at the knee is changing less and at a lower intensity than if one were climbing stairs or running. Also, the major differentiating joints of the body can be understood as a hierarchy where a joint that regulates a smaller appendage is differentiating the body less at its full extent of change than a major joint that is differentiating at a lower rate. For example, flexing a finger or wrist fully and violently is differentiating the body as a whole much less than casually flexing the hip or back. This information of a nested hierarchy of the joints of the body in terms of their ability to differentiate the body as a whole is fed into a diagram

that that registers differentiation in degree and intensity over time according to the range of actions described above (fig. 2.6).



Fig. 2.6 Joint Hierarchy and Magnitude

These diagrams are generated by plotting circles at an increment of time of a size range that corresponds to the potential differentiation of the joint they are representing, and are spaced horizontally and vertically so as to interfere with each other at certain extremes. What emerges when a range of actions are plotted and compared are specific rhythms and patterns that represent the motility of the dynamic body at rest and in action. The diagrams represent the specific way that the body becomes different over the course of a specific action (fig. 2.7-8).

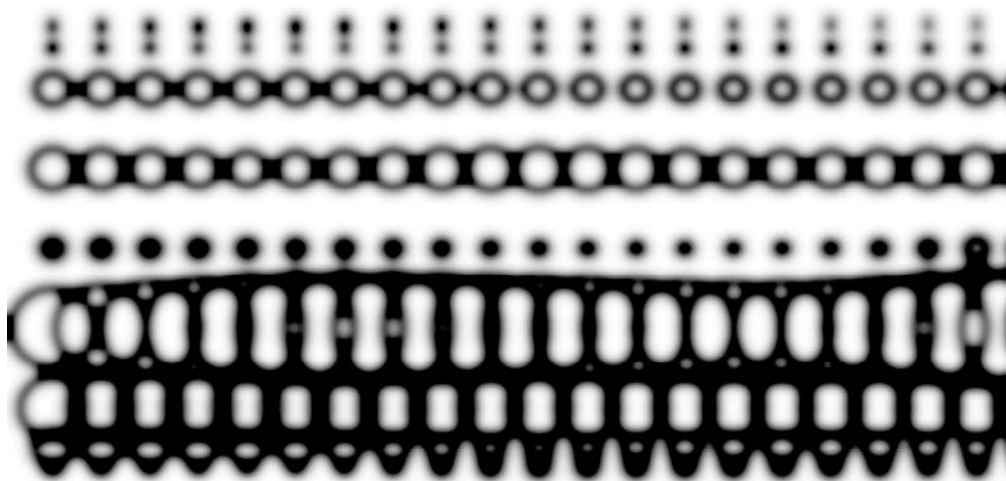


Fig. 2.7 Action Diagram : Walking

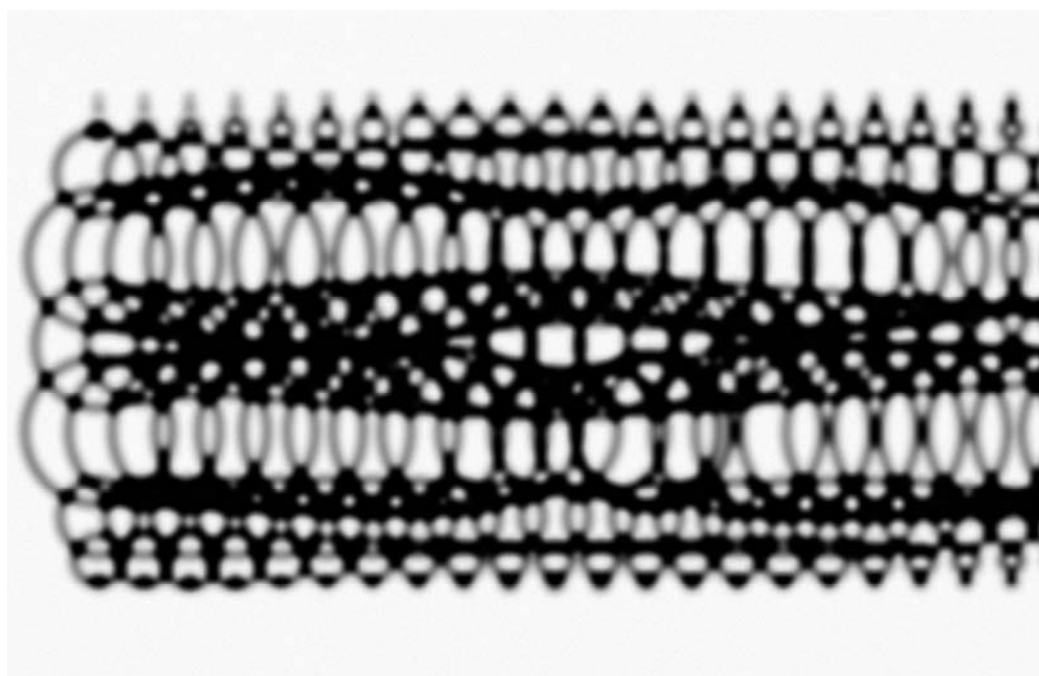


Fig. 2.8 Action Diagram : Running

These serve as proprioceptive diagrams in that they relate the individual changes and movements of the body only to other changes and the body as a whole. They can be applied to any potential movement, but are not prescribing any one movement, merely emerging from it. The diagrams are not specific to any one place, but symptoms of

certain performances and events; they are at once of the environment and of the body. As the diagrams are a reading of movement over time rather than space and they ultimately begin to describe situation and the unconscious rhythms of orienting in a landscape.

According to Massumi in chapter 8 of *Movement Affect and Sensation*, we normally go about most of our everyday lives on this habitual autopilot, driven by half-conscious tendencies gnawing at us like mild urban hungers. Orienting is more like intuitively homing in on the food with your eyes closed than it is like reading a map. The way we orient is more like a tropism (tendency plus habit) than cognition (visual form plus configuration). Recent studies assumed the traditional cognitive model based on reading visual cues embedded in the forms and configurations of objects. It was found however that the brain's ability to orient increased the emptier the space. The conclusion was that humans orient more by the shape of the space than the visual characteristics of what's in it. The studies were suggesting the proprioceptive was more dependable, more fundamental to our spatial experience than exoreferential visual cue system (Massumi 177-88). These action diagrams are not quite at the level of habit. They represent monads, or the smallest reducible components of a habit. These monads are compiled into habits or scripts that begin to serve as 'mental tapes' of various durations that are stored and called upon as the fundamentals of orienting. These tapes operate strictly in terms of the specific rhythms and intensities that comprise them and can range from a trip to the bathroom to habits of a typical day or week.

In architecture, habit manifests itself as program. As opposed to a relatively program-less design such as a park or sidewalk, an office building or school filters and interprets habit and situation into a programmatic organization. Such interpretations commonly manifest themselves as agents designed to maximize the function of a space or progress toward multi-functionality. To do so is clearly to adhere to a mechanistic understanding of the body through determinate space. Habits should not be understood as the sculpting of a passive schema that archives its actions to enable only their

repetition. The schema consists of rhythms and periodic patterns and it is these that allow variability and change. To design for the dynamic body schema is to modulate space to maximize the potential performance of the body in less determinate space. With the idea of rhythmicity, an act is never completely certain, it always differs from itself and is always ready to shift into another act, or even become a ‘free act’, and the diagrams effectively accommodate this uncertainty (Spuybroek 12). The proprioceptive diagrams developed above begin to form a tool that can inform design towards eliciting the dynamic body in space, but first it must be noted that actions alone are merely monads of habit. Further, architecture rarely is designed to serve one body so it is also necessary to proliferate the habit scripts into a field and to understand what symptoms of the field will inform its organization and ultimately feed forward into the organization of an environment.

CHAPTER 3:

Environment

According to Gibson, the terrestrial environment is better described in terms of its components: medium, substances and the surface that separate them. A surface serves as the interface between any two of these three states of matter –solid, liquid, and gas. A gas or liquid then becomes a medium for animal locomotion. Further, there are no sharp transitions in a medium. There are no boundaries between one volume and another, that is to say no surfaces, and this homogeneity is crucial. It is what permits light waves and sound waves to travel outward from a source in spherical wave fronts as well as what makes a chemical emanation from a source foreign to the medium itself and thus capable of being smelled. Substances are usually opaque to light and tend to be homogenous. They are structured in a hierarchy of nested units and these different components have

very different possibilities for the behaviors of animals in terms of eating, resting, locomotion, manipulation, and manufacture. The medium is separated from the substances of the environment by surfaces. In other words, the surface is the portion of a substance that is exposed to the medium. Insofar as substances persist their surfaces persist, and all surfaces have a certain layout and the layout also tends to persist. The persistence of the layout depends on the resistance of the substance to change. For example, if a substance is changed into a gaseous state it is no longer substantial and the surface together with its layout ceases to exist. If we understand the notion of medium, an entirely new way of thinking about perception and behaviors presents itself. To summarize, Gibson provides these statements in order to provide a new way of describing the environment:

1. All persisting substances have surfaces and all surfaces have a layout
2. A surface has a resistance to deformation depending on the *viscosity* of the substance
3. A surface has resistance to disintegration depending on the *cohesion* of the substance
4. A surface has a characteristic texture depending on the composition of the substance. It generally has both a layout texture and a pigment texture
5. A surface has a characteristic shape or a large scale layout
6. A surface may be strongly or weakly illuminated in light or in shade
7. An illuminated surface may absorb either much or little of the illumination falling on it
8. A surface has a characteristic distribution of the reflective ratios of the different wavelength of the light, depending on the substance, i.e., its color (Gibson 16-22).

Texture, which might be thought of as the structure of a surface, is distinguished from the structure of the substance underlying the surface. A natural substance is seldom homogenous, but more or less aggregated of different homogenous substances and it is seldom amorphous, but is more or less aggregated of crystals and chunks and pieces of

the same stuff. The surface of a natural substance is also neither homogenous nor amorphous but has both chemical and physical texture. It is generally both conglomerated and corrugated and it has both a pigment texture and a layout texture. Units of texture are generally nested within one another at different levels of size. The texture of commercial sandpaper can be graded from fine to rough, but the texture of vegetation cannot (Gibson 18). The texture in each case specifies what the substance is, what the surface is made of, but more importantly has a specific interface with visual perception that begins to move toward synesthetic possibilities.

Haptic Space/Smooth Space

The synesthetic potentials that constitute the body-schema begin to emerge through this rich topic of surface texture. You do not have to touch velvet to know that it is soft, or a rock to know that it is hard. Presented with a substance you have never seen before, you can anticipate its texture. Of course, this ability to see new tactile qualities depends on past touchings of other textures and movements providing continuous visual-tactile feedback. You have to know texture in general before you can see a specifically new texture, but that does not change the fact that once you can generally see texture, you see a texture directly, with your eyes, without reaching. Vision has taken up a tactile function at this scale. It has arrogated to itself the function of touch. This purely visual touch is a synesthesia proper to vision; a touch only as the eyes can touch. This is what Deluze and Guattari call the *haptic*; ‘What besides sight can feel texture at a glance?’ (Gibson 21). We can now distinguish close-range vision as distinguished from long-distance vision; tactile, or rather haptic or smooth space, as distinguished from optic or striated space. Haptic is a better word than tactile since it does not establish an opposition between two sense organs, but rather invites the assumption that the eye itself may fulfill

this non-practical function. Deleuze and Guattari thoroughly describe this distinction between smooth and striated space.

In smooth space, movement is a vector, a direction-force product, and not a dimension or metric determination. It is a space constructed by local operations involving changes in direction. These changes in direction may be due to the nature of the journey itself, as with the nomads of the archipelagoes; but it is more likely to be due to the variability of the goal or point to be attained, as with the nomads of the desert who head toward local, temporary vegetation. Directed or not, and especially in the latter case, smooth space is directional rather than dimensional or metric. It is an intensive rather than extensive space, one of distances, not of measures and properties. Local, haptic determinations result in global paths not reducible to one individual decision. Perception in it is based on symptoms and evaluations rather than measures and properties. Haptic space is a synesthetic space where no one extero- or proprioception is dominant; they mix relatively equally towards the construction of a lived experience. Striated space, on the contrary, is canopied by the sky as a measure and by the measurable visual qualities deriving from it (Deleuze Guattari 474-83). A qualitative space of moving step by step, self-reference accords better with my navigationally competent sense of where I am. Place arises from a dynamic of interference and accord between sense dimensions. A synesthetic system of cross referencing supplements a systemic duality, exoreferential and self-referential, positional and moving, Euclidean and self varying. Look at things from the proprioceptive side. Its elements are twists and turns, each of which is already defined relationally or differentially by the joint nature of the proprioceptors, before entering into relation with each other. The elements fuse into a rhythm. The multiplicity of constituents fuses into a rhythm. The resulting patch is a self varying monad of motion a dynamic form figuring only vectors. It is a qualitative space of variation referenced only to its own movement, running on autopilot. It is not a space of measure. To get a static measurable accurately positioned visual form you have to

stop the movement. This capsizes the relation between movement and position. Now position arises out of movement. Static form is extracted from dynamic space. As a qualitative limitation of it. An anexact vector space feeds its self variational results into the limitative conditions of quantitative, Euclidean space, populated by traditional geometric forms plottable into configurations. The hinge dimension between quantitative and qualitative space is itself a topological figure-to the second degree, since topology already figures in it. It is a topological hyper-figure. The hinging of the proprioceptive on the visual in the movement of orientation is a synesthetic interfusion. Each side, for example, enters into its own synesthetic fusion with the tactile: a determinate, passionate sight is a potential touch; the tropism for proprioceptive twisting and turning is assisted by past and potential bumps and the tactile feedback from the soles of the feet (Massumi 180-81).

With close vision, space is not visual; or rather the eye itself has a haptic non-optical function: no line separates earth from sky, which are of the same substance. There is neither horizon nor background nor perspective nor limit nor outline or form nor center, there is no intermediary distance, or all distance is intermediary, like Eskimo space. There exists a nomadic absolute, as a local integration moving from part to part and constituting smooth space in an infinite succession of linkages and changes in direction. It is an absolute that is one with becoming itself, with process. If we now turn to the striated and optical space of long distance vision we see that the relative global that characterizes that space also requires the absolute, but in an entirely different way. The absolute is now the horizon or background, in other words the encompassing element without which nothing would be global or englobed. It is against this background that the relative outline or form appears. The absolute itself can appear in the encompassed but only in a privileged place well delimited as a center which then functions to repel beyond the limits anything that menaces the global integration. We can see clearly here how smooth space subsists but only to give rise to the striated (Deleuze Guattari 493-94).

Affordance

We can begin to understand the forces and symptoms that locally influence the movements of smooth space through Gibson's concept of affordances. The affordances of the environment are what it offers an animal. What it provides or furnished either for good or ill. The verb to afford is found in the dictionary but the noun affordance is not, as an affordance of support for a species of animal, however, they have to be measured relative to the animal. They are unique for that animal. They are not just abstract physical properties. An affordance points in both ways, to the environment and to the observer. Why has man changed the shape and substances of his environment; to change what it affords him? He has made more available what he benefits him and less pressing what injures him. But I now suggest that what we perceive when we look at objects are their affordances, not their qualities. We can discriminate the dimensions of difference if required to do so in an experiment, but what the object affords us is what we normally pay attention to. The special combination of qualities into which an object can be analyzed is ordinarily not noticed. The theory of affordances rescues us from the philosophical muddle of assuming fixed classes of objects each defined by its common features and then given a name. As Wittgenstein knew you cannot specify the necessary and sufficient features of the class of things to which a name is given; they have only a family resemblance. But this does not mean you cannot learn how to use things and perceive their uses. You do not have to classify and label in order to perceive what they afford. The bench scissors, piece of leather, etc. offer themselves to the subject as poles of action through combined values and they delimit a certain situation, an open situation moreover which calls for a certain mode of resolution. The richest and most elaborate affordances of the environment are provided by other animals and for us other people. These are of course detached objects with topologically enclosed surfaces, but they

change the shape of their surfaces while retaining the same fundamental shape. They move from place to place changing the postures of their bodies ingesting and emitting certain substance and doing all this spontaneously initiating their own movements, which is to say that their movements are animate. These bodies are subject to the laws of mechanics and yet not subject to the laws of mechanics, for they are not governed by these laws (Gibson 127-33).

Fields of Forces

Clearly, it is this haptic, smooth space in which proprioception operates immediately and the body is most dynamic as the senses are most intensely feeding into each other. How then can the proprioceptive scripts of orientation developed previously be organized to effectively accommodate and ultimately represent this concept of smooth space? This will be achieved through the strategic proliferation of scripts into a field of forces that can intensively organize as a material phenomenon, or a haptic map. These maps will serve to move beyond the description of one body in space toward a proliferation of bodies that will ultimately describe the symptoms and conditions of smooth space through a bottom up process where individual actions are translated into rhythms and intensities that are then proliferated and organized into these fields of proprioceptive forces. These temporal maps of situation must present themselves as able to inform surface and space in a process that links the dynamic body to architecture of performance through material phenomena. First, it is important to understand such material phenomena in terms of their intensive qualities and forces that result in an active material organization and differentiation.

Magnetic Fields

In physics, a magnetic field is a field that permeates space and which exerts a magnetic force on moving electric charges and magnetic dipoles. Magnetic fields surround electric currents, magnetic dipoles, and changing electric fields. When placed in a magnetic field, magnetic dipoles align their axes to be parallel with the magnetic field, as can be seen when iron filings are in the presence of a magnet. In classical physics, the magnetic field is a vector field (every point in the field has both a specific direction and force). The field can be both defined and measured by means of a small magnetic dipole (i.e., bar magnet). The magnetic field exerts a torque on magnetic dipoles that tends to make them point in the same direction as the magnetic field (as in a compass), and moreover the magnitude of that torque is proportional to the magnitude of the magnetic field. Therefore, in order to measure the magnetic field at a particular point in space, a small freely-rotating bar magnet (such as a compass) can be utilized. Like any vector field, the magnetic field can be depicted with field lines -- a set of lines through space whose direction at any point is the direction of the local magnetic field vector, and whose density is proportional to the magnitude of the local magnetic field vector. The level of detail at which the magnetic field is depicted can be increased by increasing the number of lines (Merrill 21-22). Various physical phenomena have the ability to materialize magnetic fields. For example, iron filings placed in a magnetic field will line up in such a way as to visually show magnetic field lines; although a close inspection will reveal that the "lines" are not quite continuous. Note that when a magnetic field is depicted with field lines, it is not meant to imply that the field is only nonzero along the drawn-in field lines. The field is typically smooth and continuous everywhere, and can be estimated at any point. Magnetic fields represented by iron filings are misleading as the

field is continuous and three dimensional. The true material form of a magnetic field can be more accurately observed in Ferro fluid.

A Ferro fluid is a liquid which becomes strongly polarized in the presence of a magnetic field. It is a colloidal mixture comprised of extremely small magnetic particles suspended in synthetic oil. The particles are small enough for thermal agitation to disperse them evenly within a carrier fluid, and for them to contribute to the overall magnetic response of the fluid. When a paramagnetic fluid is subjected to a sufficiently strong vertical magnetic field, the surface spontaneously forms a regular pattern of corrugations; this effect is known as the normal-field instability. The formation of the corrugations increases the surface free energy and the gravitational energy of the liquid, but reduces the magnetic energy (Merrill 84-88). The corrugations will only form above a critical magnetic field strength, when the reduction in magnetic energy outweighs the increase in surface and gravitation energy terms (fig. 3.1).

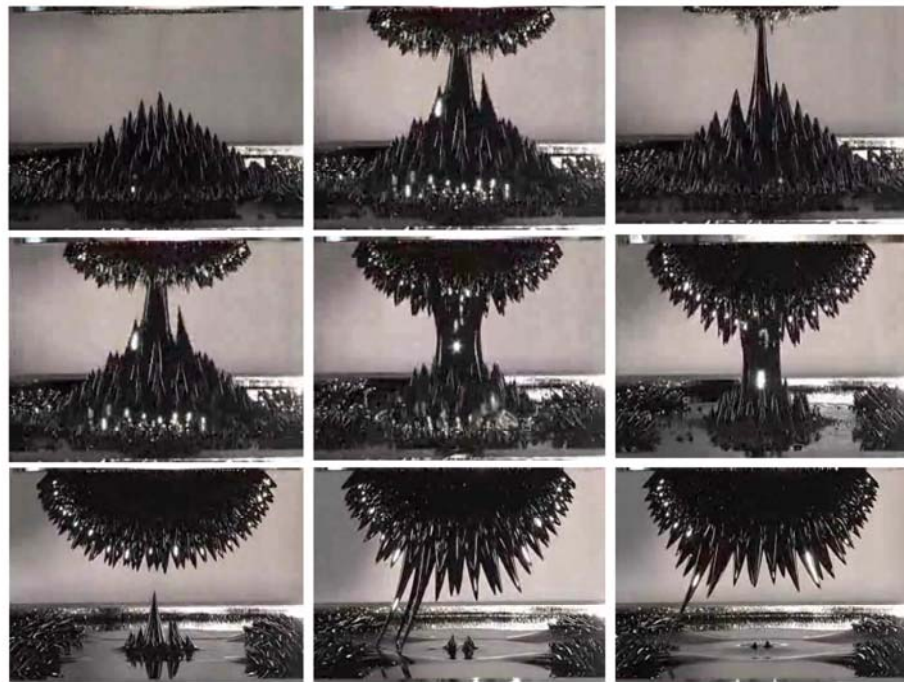


Fig. 3.1 Ferro Fluid

When the magnetic field is removed, the particles go back to random alignment very quickly. A Ferro fluid will always tend to move to the region of highest flux. This

can create interesting patterns when magnets of different shapes are used. In any case, these magnetic fields exemplify a material phenomenon where a field of forces modulates toward a specific organization. In the case of iron filings, the magnetic elements are aligned and attracted in an invariant way producing predictable landscapes of clumps and voids with specific orientations and intensities. The Ferro fluid is more dependant on its intrinsic material parameters, but nevertheless organizes spontaneously according to the prescriptive orientations and intensities of the magnetic field in three dimensions. In both instances, a form emerges that represents the intensive qualities of the field of forces that defines it. This form is at once describing these forces as well as the inherent limits of the material itself.

Weather

At a macro scale, weather is a material system emerging from various thermodynamic conditions of the atmosphere. Weather is defined as the set of all extant phenomena in a given atmosphere at a given time. It also includes interactions with the hydrosphere. The term usually refers to the activity of these phenomena over short periods (hours or days), as opposed to the term climate, which refers to the average atmospheric conditions over longer periods of time. Weather most often results from temperature differences from one place to another. On large scales, temperature differences occur because areas closer to the equator receive more energy per unit area from the Sun than do regions closer to the poles. On local scales, temperature differences can occur because different surfaces (such as oceans, forests, ice sheets, or man-made objects) have differing physical characteristics such as reflectivity, roughness, or moisture content. Surface temperature differences in turn cause pressure differences. A hot surface heats the air above it and the air expands, lowering the air pressure. The resulting horizontal pressure gradient accelerates the air from high to low pressure,

creating wind, and Earth's rotation then causes curvature of the flow via the Coriolis Effect. The simple systems thus formed can then display emergent behavior to produce more complex systems and thus other weather phenomena. The strong temperature contrast between polar and tropical air gives rise to the jet stream. Most weather systems in the mid-latitudes are caused by instabilities of the jet stream. The atmosphere is a chaotic system, so small changes to one part of the system can grow to have large effects on the system as a whole. Large semi stable systems begin with specific air masses. An air mass is a vast pool of air having similar temperature and moisture characteristics over its horizontal extent. Air masses are born in a source region where they take on their characteristic temperature and moisture content and are some combination of arctic, polar, tropical, equatorial, and maritime or polar (fig 3.2).

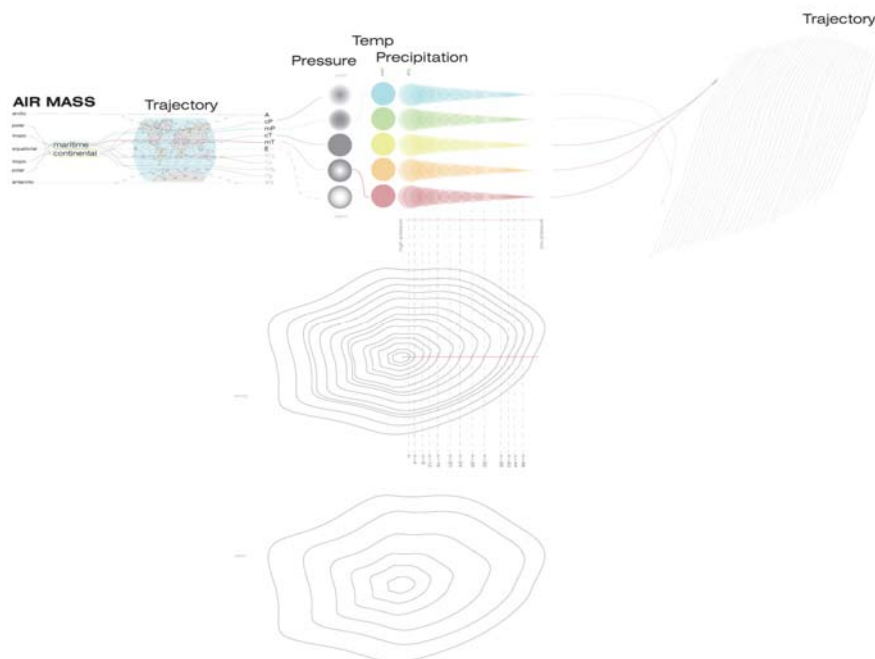


Fig. 3.2 Air Mass Qualities

Radiation and vertical mixing of heat yield equilibrium between the conditions at the source region and the properties of the overlying air mass. Areas dominated by high pressure serve as good source regions where subsidence pushes the air toward the surface (Strahler 14-33). High pressure also enables the air to move outward from the source

region. Fronts are boundaries between contrasting masses of air. Atmospheric scientists recognize fronts of different spatial scales. These range from the quasi-stationary fronts along which cyclones form to "weather" fronts embedded in cyclones. Fronts are three-dimensional features. At the global scale are quasi-stationary fronts found migrating within a particular latitudinal zone throughout most of the year. The polar front is the boundary between polar-type air and tropical-type air. Above the polar front is found the polar front jet stream, a high velocity corridor of wind that controls the development and movement of mid-latitude cyclones. Appropriately called "wave cyclones", these systems take the form of an ocean wave when fully developed. These vast areas of low pressure are born along the polar front where cold polar air from the north collides with warm tropical air to the south. In so doing, huge spiraling storms move across the surface guided by the polar front jet stream. At the location where the opposing streams of air meet, cyclonic shear is created from opposing air streams sliding by each other causing the air to spin. Once the air collides and cyclonic circulation commences, warm air from the south invades where cold air was once located north of the polar front. A warm front develops where warm air replaces the cold air. To the west of the center of the developing system, cold air is sliding south replacing warm air at the surface. A cold front (blue triangles) develops where cold air replaces the warm air. Soon the developing system takes on the characteristic wave form, hence their name "wave cyclone". The lowest pressure is found at the center or apex of the wave. The weather associated with the passage of a wave cyclone is a product of the convergence and frontal uplift found in the system. The wave cyclone can be divided into three sectors: the cool sector ahead of the warm front, the warm sector between the cold and warm fronts, and the cold sector located behind the cold front. The cold sector generally has the lowest temperatures as cold air is coming from a northerly direction. Air in the cool sector is coming from an easterly direction so it is warmer than the air in the cold sector. In the warm sector air is entering the system from the south so we should expect to find the warmest temperatures

in this region. Since cold air is typically denser than warm, the cold front begins to move faster than the cold front and the system begins to occlude (Strahler 34-38). At a certain point the cold front catches up with itself as the warm front is swallowed up and the system resolves itself, primed to repeat the process (fig. 3.3).

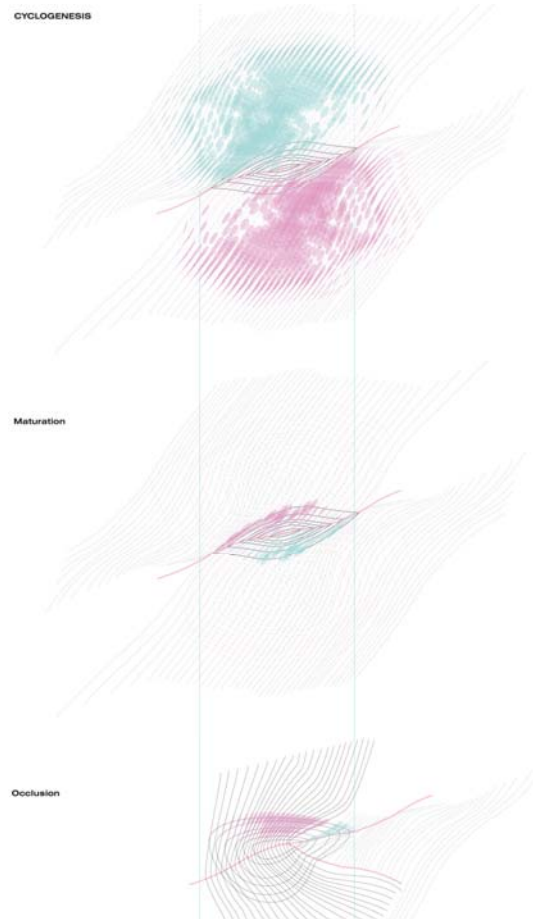


Fig. 3.3 Cyclone Resolution

As a material system, weather represents the emergent organization of the relationships between the earth's thermodynamic forces, water cycles, and land forms.

Haptic Maps

In order for the proprioceptive scripts to begin to describe the qualities of a specific haptic space, they must approach a field condition similar to those described

above. The forces of proprioception must begin to act as a material system. This first act is to condense the action scripts into molecules with distinct qualities (fig. 3.4-5).



Fig.3.4 Walking Monad



Fig. 3.5 Running Monad

This is achieved by extruding the representative forces and combining them along a single path. Each respective joint is coded with a color and made transparent. The resulting monads can then be combined into hypothetical scripts. The next step is to proliferate a field with a specific sample of these scripts. In order to move toward the description of a situation that is particular to a specific space, the sampling must be gated to a certain territory. This means that a body is only sampled during the time it is within the given boundary and truncated scripts of various lengths will emerge. This method of gaiting, as opposed to selecting a fixed and specific number of bodies to sample along a period of time, represents the specific haptic qualities of a situation in a specific place, rather than a situation in a larger more vague space as the bodies in the later scenario may rarely be in physical proximity. Once a field is populated with the sampled scripts over a period of time, forces must begin to organize the field as a material system. This is achieved by coding a range of forces of attraction and repulsion to the various monads that comprise the individual scripts. Monads of similar quality will first be attracted toward each other at similar moments of time, introducing curvature to the scripts. Then monads of opposite quality will repel each other at similar moments adding another degree of curvature. For example, actions such as running and climbing will be attracted towards other running and climbing monads, but will be repelled by sleeping or watching

monads. In the third dimension, the scripts will simultaneously be pulled apart to avoid intersections. As more samples are introduced, the curvature and order of the system will increase and the resulting haptic map is specific at once to its smooth space and the dynamic bodies that are engaging it over time.

CHAPTER 4:

Implementation

In architecture, habit and routine serve as the outset for design and are manifested as program; as the mechanistic layout of routine. It is apparent that throughout history, a mechanistic understanding of the body has prevailed in design fields such as ergonomics and human factors at large, but when a dynamic concept of the body schema is introduced, it is clear that these ideas are completely limiting to the potential performance of the body. The static metrics of ergonomics and anthropometry become nothing more than fleeting moments in a continuously variable system. Rather than fixed postures we have plastic rhythms and patterns that are constantly unfolding and on the verge of shifting to another act. The body schema is never something fixed a priori in the brain, but a process adapting itself all the time to unfolding experience. Habits cannot be understood as mechanistic repetitions of past actions, as they are much more indeterminate than this could allow. The schema consists of intensities and rhythms in some degree of constant variation, and it is this undeniable variation, or motility of the body that denies any mechanistic model of human behavior. This is not to say that there can be no program, architecture clearly begins with habit and routine. The dynamic schema begs for an understanding of habit as potentially flexible (Spuybroek 12-13). With an open concept of habit, we now have a more indeterminate concept of program in architecture, but its degrees of freedom must be regulated to specific situational and

programmatic necessities. It is at this moment of consolidation that the haptic maps are tailored and parameterized into a final system that will produce an architectural morphology.

This consolidation begins by bringing the developed diagram to a specific program and site. It is here that a range of scripts will be compiled relative to a specific program. This will not aim to approximate a specific number of occupants during a specific time frame, but more importantly (and accurately) will serve to approximate the various open habits of its occupants based on the specific program and their potential to interact. For example, if the program is a private business then there will be certain rhythms for the people that work in the space and will remain there for a long period of time. On the other hand, visitors to the space will have distinctly shorter and more intense rhythms. In a completely public program, such as a train station, the rhythms will more homogenous, but the durations will be more unpredictable and be represented with a wider range. In a completely private setting, rhythms may be more sporadic yet casual. The scripts that populate the haptic maps will serve as the first step in creating programmatic relationships, and their selection is very much a design decision, or a meta-design decision. Once the maps are proliferated and organized, the symptoms for a performative, smooth space emerge. In an act of construction the consolidated habit scripts organized into a field of forces that has the potential to inform surface, structure or massing. Individual postures became group posture, or group-schemas that are configured and reconfigured as new elements are added and old elements taken away from the system. These three elements, surface structure and massing, must be coded in relation to the haptic maps in such a way that they are modulated toward specific architectural intentions and limitations of site and program, as the system is further consolidated and an architectural morphology emerges. From this morphology design is further refined and the result is a permanent actualization of an 'architecture-schema', a permanent interface between body, group, and form modulating a field of perceptual

forces. Rather than determinate programmatic junctions or progressively neutralized space of multi-function, this becomes a less determinate space of performance. This is an inherently synesthetic space, a haptic space where the constructive process of perception is productively interfered with by the architectural landscape. Ultimately this type of space serves as a body/group modulator tuned to specific programmatic goals and limitations; a material system capable of eliciting the unfolding of experience.

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